1.2 Identifying and Solving Problems with New Technologies

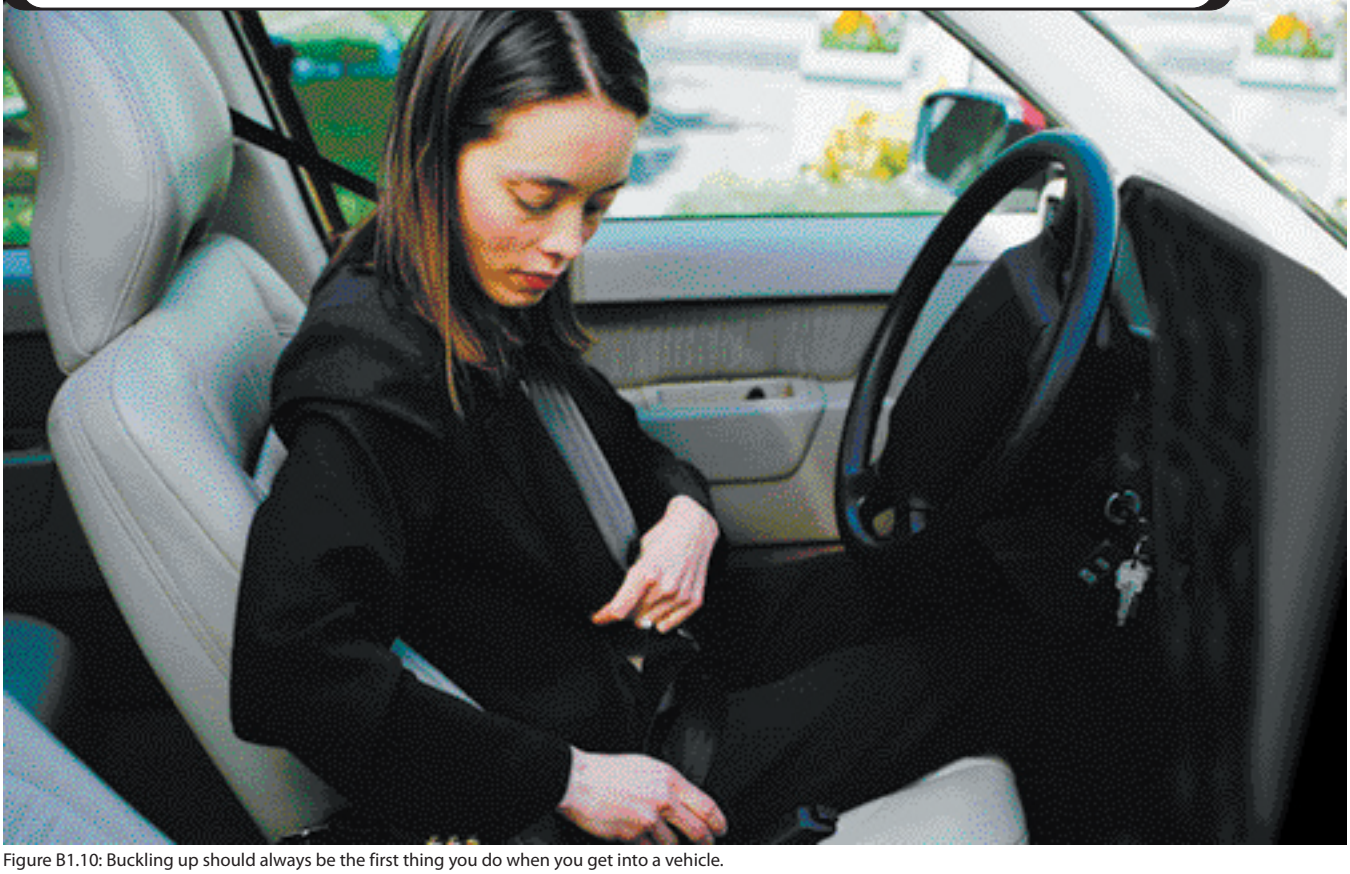

Figure B1.10: Buckling up should always be the first thing you do when you get into a vehicle.

A surprising spinoff from modern automotive designs is that vehicles have become so comfortable that drivers can lose their sense of how fast they are actually travelling. In this case, technology designed to solve one set of problems—decreasing road noise and providing a more comfortable ride—has created a whole new set of unintended problems. Improvements to soundproofing and suspension systems have made drivers so comfortable that, in some cases, they become disconnected from the hazards associated with driving. When travelling at highway speeds, a vehicle moves surprisingly long distances in relatively short times.

Example Problem 1.3

During an intense sneeze, a driver's eyes can remain closed for about 0.50 s. If the vehicle is moving 100 km/h, how many metres does the car travel during this time? Provide an example of a comparable distance.

Solution

$$v = 100\ \frac{\text{km}}{\text{h}} \times \frac{1000\ \text{m}}{1\ \text{km}} \times \frac{1\ \text{h}}{3600\ \text{s}}$$
$$= 27.\overline{7}\ \text{m/s}$$

$\Delta t = 0.50$ s

$\Delta d = ?$

$$v = \frac{\Delta d}{\Delta t}$$
$$\Delta d = v\Delta t \quad \leftarrow \text{Rearrange the formula to find the distance.}$$
$$= (27.\overline{7}\ \text{m/s})(0.50\ \text{s}) \quad \leftarrow \text{Enter the known values.}$$
$$= 14\ \text{m}$$

During a sneeze, a driver's eyes can remain closed for 14 m while travelling 100 km/h. This distance is equal to about three car lengths.

The solution to Example Problem 1.3 reminds you that the math skills you developed in Unit A apply to the other units in Science 20 as well. Note that units were dealt with first and that the values for speed and time were not substituted until the equation was rearranged.

Practice

9. Dana reaches into the backseat to get one of her favourite CDs to load into her car's player. If this takes her eyes off the road for 2.0 s, determine the number of metres she would travel if her car was moving
   a. 30 km/h (maximum speed in school zones)
   b. 50 km/h (maximum speed on most residential streets)
   c. 80 km/h (maximum speed on most gravel roads in Alberta)
   d. 110 km/h (maximum speed on some divided highways in Alberta)
10. Even if a driver has every intention of staying focused on driving, sometimes events beyond a driver's control can happen, resulting in the driver being distracted for a few seconds. During the time a driver is distracted, the vehicle continues to move. Extend this reasoning to explain why driving an automobile at speeds in excess of the posted speed limit is so dangerous.

Driving at Night

Driving at night presents other challenges to a driver. The small area that can be illuminated by a vehicle's headlights provides a driver with limited information about the road ahead. When conditions are clear—no rain or snow—headlights with halogen bulbs can illuminate up to 60 m of the road ahead.

The speed of the vehicle determines the amount of time the driver has to detect and react to situations that apear on the road ahead.

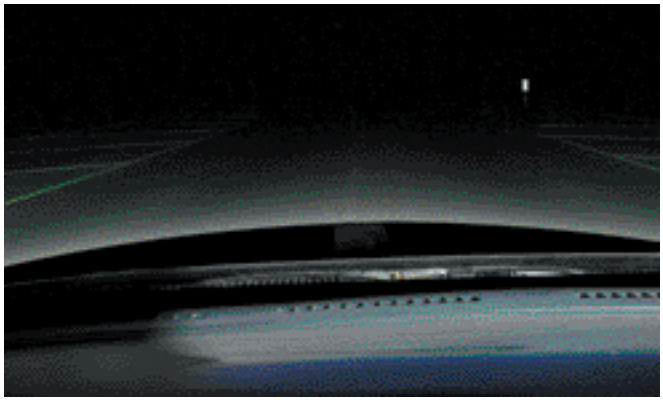

Figure B1.11: In ideal night-driving conditions, standard halogen-bulb headlights illuminate up to 60 m of the road.

Example Problem 1.4

While travelling down a dark country road, the headlights on Manpreet's truck allow him to see up to 60 m of the road ahead. If he is travelling 70 km/h, how many seconds will it take Manpreet to reach the furthest point of his headlights' beam?

Solution

$$v = 70\ \frac{\text{km}}{\text{h}} \times \frac{1000\ \text{m}}{1\ \text{km}} \times \frac{1\ \text{h}}{3600\ \text{s}}$$
$$= 19.\overline{4}\ \text{m/s}$$

$\Delta d = 60\ \text{m}$

$\Delta t = ?$

First, rearrange the formula to find the elasped time, Dt.

$$v = \frac{\Delta d}{\Delta t}$$
$$v\Delta t = \frac{\Delta d}{\Delta t}(\Delta t)$$ ¨ Multiply both sides by Dt.
$$v\Delta t = \Delta d$$
$$\frac{v\Delta t}{v} = \frac{\Delta d}{v}$$ ¨ Divide both sides by v.
$$\Delta t = \frac{\Delta d}{v}$$

Now, enter the values and solve for time.

$$\Delta t = \frac{\Delta d}{v}$$
$$= \frac{60\ \text{m}}{19.\overline{4}\ \text{m/s}}$$ ¨ Use the unrounded value of speed.
$$= 3.1\ \text{s}$$

It will take Manpreet 3.1 s to reach the furthest point of his headlights' beam.

The algebra in Example Problem 1.4 is a little more challenging because Dt in the original equation is not isolated; it is also initially in the denominator. Therefore, the first step in the algebra is to multiply both sides of the equation by Dt, causing it to cancel on one side and appear in the numerator on the other side.

As was the case in Unit A, it is not necessary to show all the algebra steps in your solution. If you are able, you can streamline your solution by, first, writing the basic equation and then simply recording the rearranged version on the next line. Keep this in mind as you try the Practice questions.

Practice

11. How long will it take to drive the 439 km between Edmonton and Fort McMurray if an average speed of 95 km/h is maintained for the entire journey?
12. When most people think of tuna, the first thing that usually comes to mind is a small tin of food for sandwiches. In the ocean, the tuna is a large, fast-swimming predator with a streamlined body. Aided by ocean currents, a tuna can swim with an average speed of about 30 km/h; but it is capable of instantaneous speeds of 80 km/h. If a tuna maintains its average speed, how many days will it take it to cross the 5000-km width of the Atlantic Ocean?

13. North America drifts away from Europe at a rate of 25 mm per year. The theory that explains this phenomenon is called plate tectonics. If the thickness of a human hair is about 5.0×10^{-5} m, how many hours will it take before Nova Scotia is "a hair's breadth" farther from England?

Utilizing Technology

High-Intensity Discharge (HID) Headlights

Define the Issue

Science Skills

- ✓ Initiating and Planning
- ✓ Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communication and Teamwork

One problem with conventional halogen-bulb headlights is that they only provide illumination for about 60 m of the road ahead of the vehicle under ideal conditions. At speeds over 80 km/h, a vehicle can cover this distance in such a short time interval that the driver has insufficient time to react to any hazard that may appear. The use of high-intensity discharge (HID) headlights illuminates up to 100 m of the road ahead of the vehicle, providing the driver with improved visibility and more time to react to a potential hazard. The HID headlights also produce a wider beam, allowing drivers to detect objects, like pedestrians and animals, on the edges of the road more effectively.

However, HID headlights create a whole new set of problems for drivers in oncoming vehicles because the light produced is very glaring. The response of these oncoming drivers is to wince, squint, and possibly look away. Ironically, while the ability to see at night is enhanced for a driver in a vehicle equipped with HID headlights, the opposite can be said for drivers in oncoming vehicles.

Purpose

You will determine the risks and benefits of HID headlights. You will also be asked to develop an opinion on whether these headlights should be banned.

Identifying Alternatives/Perspectives

1. Should HID headlights be banned? Begin brainstorming alternative solutions to this question. One approach is to consider the question from as many points of view as possible. Copy and complete the following table by listing at least three stakeholders and their corresponding viewpoints.

Stakeholder	Point of View/Perspective

Researching the Issue

2. Use the Internet to collect information related to question 1 and to the alternative perspectives on this issue. As with any Internet search, your success will largely depend upon your ability to choose appropriate combinations of key words to enter into the search engine. Copy and complete the following table by attempting at least four different combinations of key words.

Key Words Entered	First Ten Listings Provided	Evaluation of Information Gathered

Analyzing the Issue

3. Analyze the results of your research by concisely organizing your findings in a risk-benefit analysis. Review your lists of risks and benefits. How would each of the stakeholders react to the entries on your lists? Record the reactions of three of your stakeholders to the data in your risk-benefit analysis.

Taking a Stand and Defending Your Position

4. Should HID headlights be banned? Take a clear position on this issue by writing a few concise paragraphs. Your position should be supported by your research and should indicate that you have considered the question from more than one point of view.

Evaluation

5. It is helpful at this stage to share your findings with others. How do their points of view differ from yours? Are the arguments made to support these views consistent with the information you researched? Did other students find additional information unknown to you? How has your position changed since you started? If you had to make this decision again, what would you have done differently? Evaluate your position and the process you used to develop your point of view by writing a few concise paragraphs. Your response should indicate that you have considered the positions of other students and that these alternative points of view have been addressed.

1.2 Summary

A technology designed to solve one set of problems can sometimes create a whole new set of unintended problems. The use of HID headlights certainly illustrates this point. It has many people wondering whether this new technology requires further modification. The process of sorting out these issues sometimes requires a mathematical analysis that relies upon algebra. Other aspects of the issues can be analyzed by listing the risks and benefits related to the use of new technology.

1.2 Questions

Knowledge

1. Copy and complete the following table by identifying the unintended problems created by each technological advancement listed.

Technological Advancement	Unintended Problems Created
improvements to soundproofing and suspension systems of vehicles	
introduction of HID headlights	

2. Show all the steps involved in rearranging the formula for average speed to isolate the following variables.

a. distance, Dd

b. time, Dt

Applying Concepts

3. Although it is true that new technologies are often problematic when they are first introduced, many of the initial troubles are often worked out as more refined, later versions of the technology are introduced. For each scenario described in the following table, describe the refinements made in later versions of the technology. You may need to use the Internet or some other source of reference material to answer this question.

Figure B1.12: New technologies in vehicle safety are constantly being produced and refined.

Initial Problem	Technology Initially Designed to Solve Problem	Unintended Problems Created	Refinements That Addressed Unintended Problems
Drivers of early automobiles had to wear goggles to protect their eyes as they drove their "horseless carriages."	A glass shield, initially called a windscreen, is installed. It is built from thick, tempered glass designed not to break.	In a collision, striking your head on such a heavily built windscreen could be fatal.	
Even though drivers and passengers use seat belts, occupants can still be seriously injured if they collide with the dashboard and windshield.	Air bags are installed in the dashboards as safety devices.	A child sitting in the passenger seat could be injured or killed by the air bag after it is deployed.	

4. During the 2002 Olympic Winter games in Salt Lake City, Catriona Le May Doan of Saskatoon won the gold medal for Canada in the 500-m speed skating event. She won with a combined time of 74.75 s for her two 500-m trials.

a. What was Catriona's average speed for her two trials in metres per second and kilometres per hour?

b. Competitors in this race skate around an oval-shaped track. During which parts of the race do the competitors travel with non-uniform motion?

c. Special suits worn by speed skaters are designed to improve performance by reducing air resistance. When special patches and strips that further reduce air resistance were added, times improved for the 500-m event by about 0.15 s. Using your answer to question 4.a., determine the distance Catriona Le May Doan travels while speed skating for 0.15 s?

d. The world's best female track and field athletes run the 400-m dash in just under 50 s. Using your answer from question 4.a., determine how many seconds would it take Catriona Le May Doan to skate 400 m. Can you account for the differences in the times for the two athletes to race this same distance?

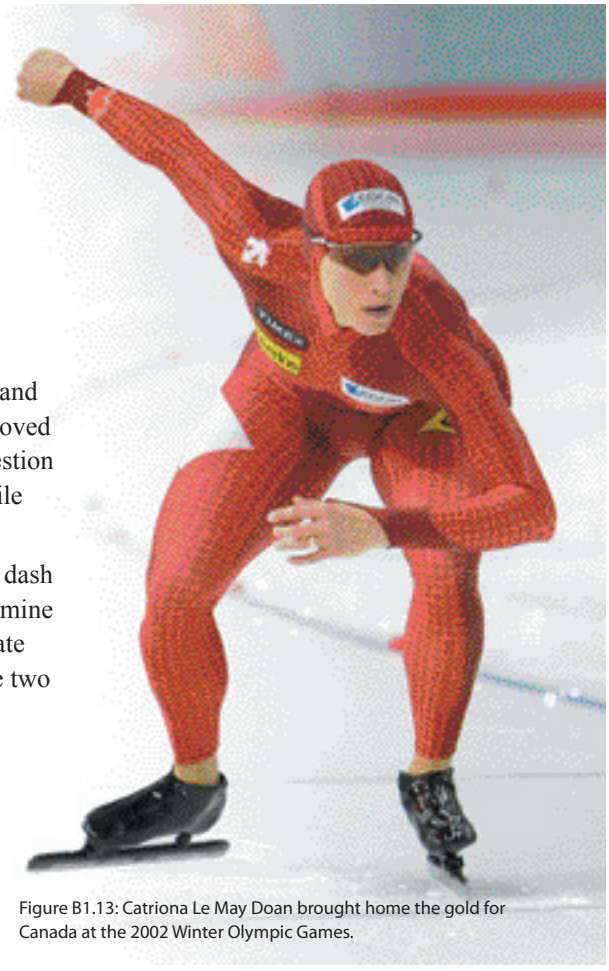

Figure B1.13: Catriona Le May Doan brought home the gold for Canada at the 2002 Winter Olympic Games.